Study on Inventory of Petroleum and Natural Gas Storage

Report to Congress as required under Section 1801
of the Energy Policy Act of 2005

Prepared by the U.S. Department of Energy
Office of Fossil Energy

U.S. DEPARTMENT OF
ENERGY

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Preface

Study Request

On August 8, 2005, President Bush signed into law the Energy Policy Act of 2005 (EPAct). EPAct directs the Secretary of Energy to submit a report no later than one year after the enactment of the Act on petroleum and natural gas storage capacity and operational inventory levels, nationwide and by major geographical regions. Specifically, Section 1801 of EPAct states that the study shall address:

(1) historical normal ranges for petroleum and natural gas inventory levels;

(2) historical and projected storage capacity trends;

(3) estimated operation inventory levels below which outages, delivery slowdown, rationing, interruptions in service, or other indicators of shortage begin to appear;

(4) explanations for inventory levels dropping below normal ranges; and

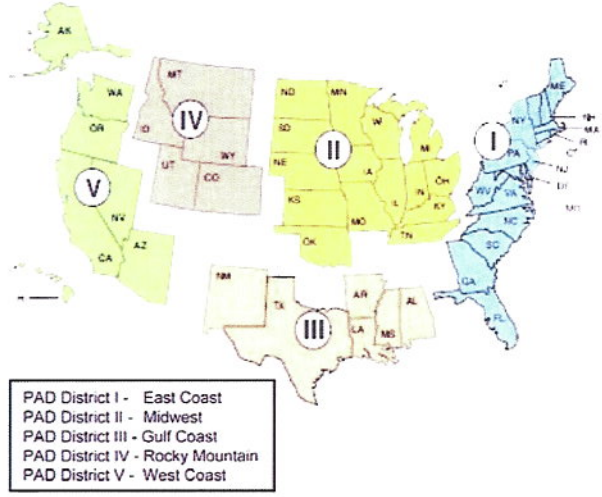
(5) the ability of industry to meet U.S. demand for petroleum and natural gas without shortages or price spikes, when inventory levels are below normal ranges.

This report responds to this Congressional request by providing an assessment of petroleum and natural gas storage capacity and inventory levels, and supply capability, including findings and recommendations for preventing future supply shortages.

Study Approach

The study evaluated petroleum and natural gas storage capacity and inventory trends on both a nationwide and regional level as of June 2006. For crude oil and petroleum products (motor gasoline, jet fuel, distillates, and propane), regional storage capacity and inventories were assessed by Petroleum Administration Defense Districts (PADD). For natural gas, U.S. Census Divisions were used. For natural gas, the study also investigated the relationship between total storage capacity, working gas capacity, and base gas capacity.

Evaluations of historical storage capacity and inventory levels were based principally on publicly available data collected and reported by the Energy Information



Petroleum Administration Defense Districts
(Source: EIA AEO 2006)

United States Census Divisions *(Source: EIA AEO 2006)*

Administration (EIA). EIA data for the petroleum inventories were reported by PADD; however, data for natural gas inventories were reported by state and aggregated into census regions. Future projections also came predominantly from EIA, but other data such as those from the National Petroleum Council (NPC), Interstate National Gas Association of America (INGAA), American Gas Association (AGA), and other petroleum and natural gas trade associations have been used. All data sources have been referenced.

Executive Summary

Inventories of crude oil, natural gas, and refined products are essential to the efficient operation of the respective supply and distribution systems. Industry seeks to optimize their stocks, balancing the cost of storage against the need to maintain sufficient supplies to ensure uninterrupted delivery in the face of fluctuating seasonal or regional demand. This report reviews historical and projected storage capacity and inventory trends for crude oil, natural gas, and petroleum products in the United States. The report, written in response to a Congressional request in the 2005 EPAct, also investigates normal inventory ranges for these commodities and the adequacy of these stock levels to meet future demand without shortages or price spikes. The key findings from this report are listed below:

Key Findings Related to Crude Oil and Petroleum Product Inventories:

- The nation's inventories of available stocks assure efficient and reliable delivery of crude oil and petroleum products to customers. Historical inventories for crude oil and the major petroleum products have fluctuated within the five-year average stock bands, and while notable events have resulted in inventories falling below the five-year averages, industry and market mechanisms have reacted quickly to these events resulting in the restoration of the supply/demand balance.
- In late 2005/early 2006, monthly inventories exceeded levels for the same month during the prior several years. This upward trend, despite a continuous rise in prices, suggests stockpiling resulting from unanticipated easing of demand growth, due in part to record warm winters and demand response to price increases, concerns of upstream constraints, limited domestic refining capacity, other potential supply disruptions, or increasing demand, with the expectation of further increases in prices.
- Inventories of crude oil and refined petroleum products provide an important buffer against unexpected supply/demand imbalances, but the nation's system for supplying refined products is operating close to its limits. Refinery operable utilization rates continue to be high, though new capacity is coming on line, and refiners and marketers are increasingly relying on finished product imports to meet demand, thereby increasing supply flexibility overall, but also increasing the risk of externally driven supply disruptions.
- Refiners' compliance with new product specifications and other (e.g., renewable) fuel mandates also may impact the ease with which products can be substituted to meet regional demand fluctuations. The introduction of increased volumes of ethanol over a wider portion of the country and the challenges of delivering ultra-low-sulfur diesel (ULSD) within specifications will increase the possibility that local supply disruptions could occur, leading to price spikes.
- Though total motor gasoline stocks have generally risen, finished motor gasoline stocks have declined relative to blending component stocks. Variations in motor gasoline formulations and the increased use of ethanol as a replacement for methyl tertiary butyl ether (MTBE) have contributed to this trend.
- Disruptive events such as last year's hurricanes provide insights into the importance of inventories and the need for a robust delivery system.
- Sustained higher demand provides industry an incentive to expand the refining, storage, and liquid pipeline network and to update aging infrastructure. Increasing urbanization,

Introduction

Importance of Petroleum and Natural Gas to the U.S. Economy

Petroleum and natural gas are important to the U.S. economy. In 2005, over 60 percent (on a Btu basis) of all energy consumed in the United States was in the form of petroleum and natural gas. These fuels are important to some degree to all sectors of the economy, but each has its particular area of key importance—petroleum accounts for 96 percent of all fuel used in transportation, while natural gas provides 73 percent of the fuel consumed for residential and commercial uses. Forecasts from the EIA indicate that petroleum and natural gas will continue their dominant role in the national energy mix through 2030, as shown in Figure 1. Petroleum and natural gas are important feedstocks for the production of materials such as plastics, fertilizers, and fabrics. Residential, industrial, and commercial consumers in the United States have become accustomed to affordable and dependable supplies of petroleum and natural gas. Strong demand for these fuels and the products they are used to create is likely to continue into the foreseeable future.

U.S. demand for petroleum and natural gas is met by domestic production and foreign imports. EIA forecasts that the rate of domestic production growth will continue to be less than the domestic growth rate in consumption. Any significant supply disruption—or even the market's perception of a supply disruption—could cause proportional spikes in the commodity price. This is true regardless of the source of the supply, whether domestic or international.

According to EIA, the ratio of total expenditures for energy relative to total gross domestic product (GDP) has fallen from a high of 14 percent in 1981 to 7 percent in 2004. Although recent developments in the world oil market have pushed the shares upward somewhat, they are projected to decline in the future. With the declining share of petroleum and natural gas expenditures in the economy per unit of GDP, changes in price or supply levels of either or both of these fuels has a diminishing effect on the economy.

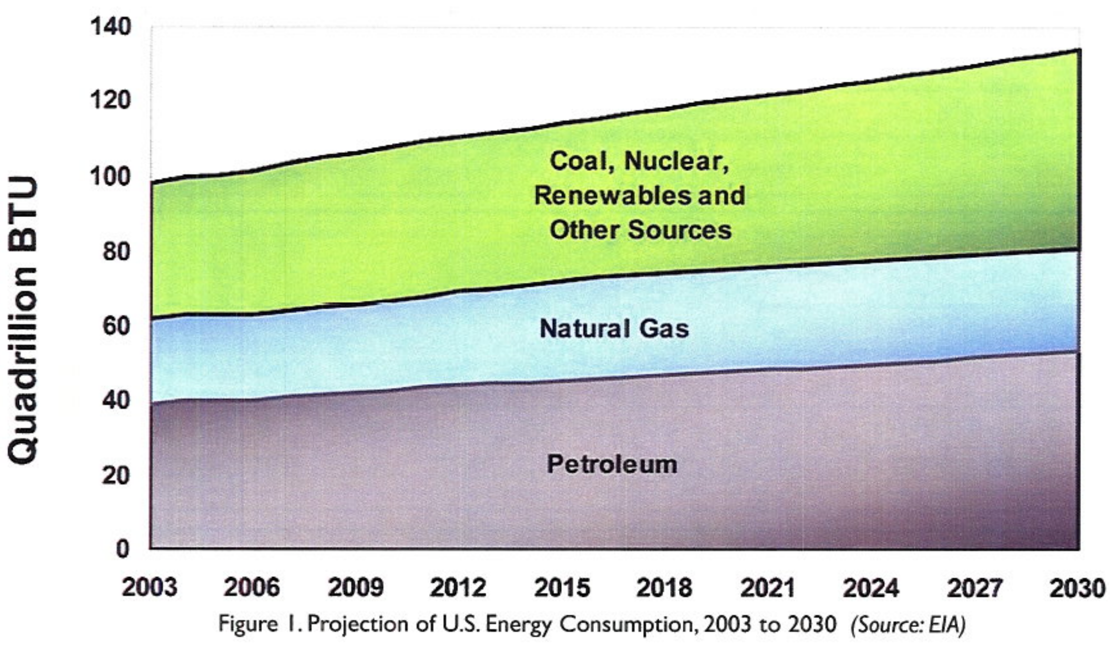


Figure 1. Projection of U.S. Energy Consumption, 2003 to 2030 *(Source: EIA)*

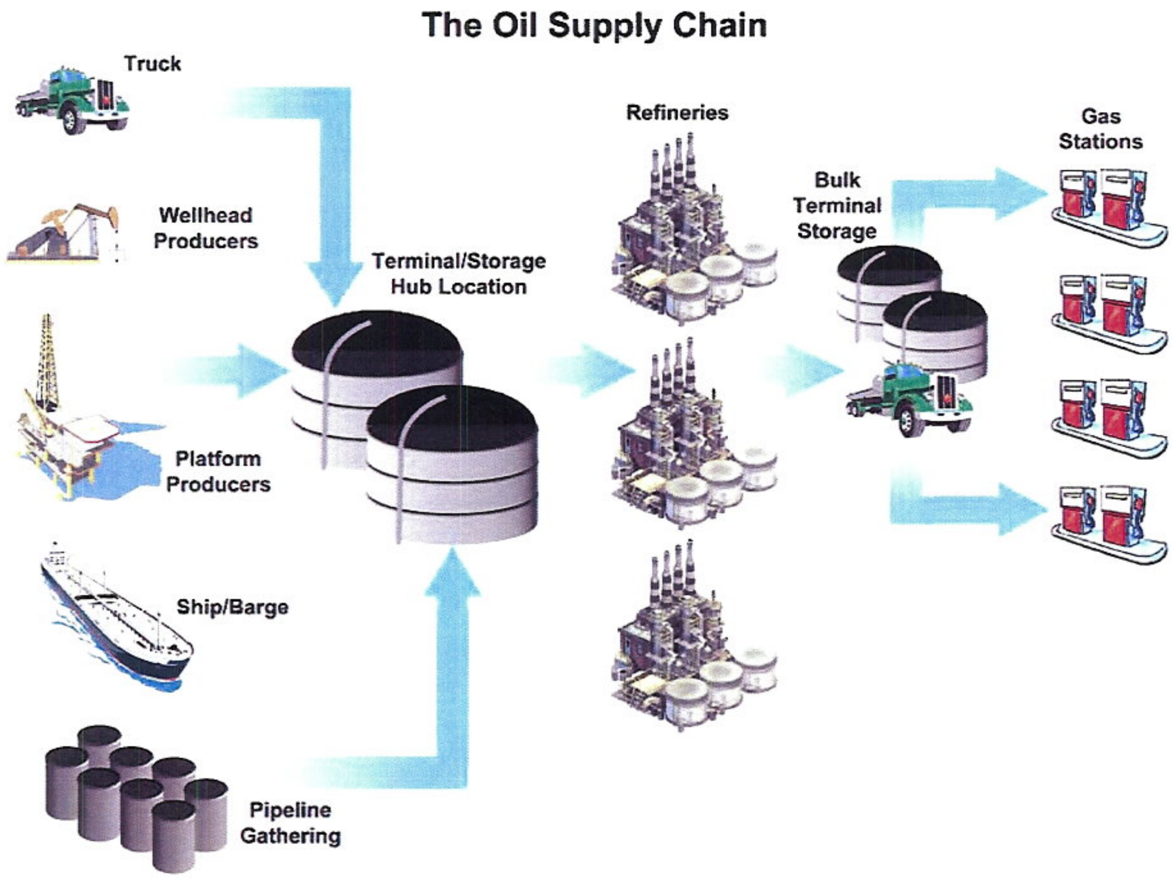


Figure 3. Crude Oil and Refined Product Delivery System

The interaction between inventories and price is complex and while U.S. inventories may not be a strong indicator of current prices, they can influence future prices which in turn can affect company decisions regarding inventories. In principle, competitive markets should send signals about future investment needs and contribute to better allocation of resources. In the past few years; however, expectations have not been driven solely by supply/demand fundamentals but also by political and psychological factors which may carry considerable weight with market participants.

The U.S. Crude Oil and Petroleum Product Delivery System

The crude oil and petroleum product delivery system begins at the wellhead where crude oil is produced, continues through the refining stages where petroleum products are made, and ends with the distribution and marketing of finished products to end-use customers. These activities are global in nature and include an immense physical infrastructure that includes drilling rigs, pipelines, ports, tankers, barges, trucks, crude oil storage facilities, refineries, product terminals, and retail storage tanks (Figure 3).

Refining crude oil results in three principal types of hydrocarbon products: gasoline, distillate (i.e., jet fuel, diesel fuel, and heating oil), and heavy oils (i.e., residual fuel oil, asphalt). In addition, a number of very light-end products such as butane and propane are produced. These products have a variety of valuable end uses including production of many of the chemicals and plastics that Americans use daily. In the United States roughly 50 percent of a barrel of crude oil is turned into gasoline, while about 25 percent is made into distillate fuels—diesel fuel and heating oil. In Europe and Asia, these shares are nearly reversed, as diesel is in higher demand for transportation fuel.

oil and five million barrels of petroleum products are distributed among the five PADDs.

Most crude oil shipments occur via pipeline from the Gulf Coast to the Midwest region. Tankers and barges account for a very small portion of crude oil shipments, occurring primarily between the Midwest and East Coast regions. Conversely, tankers and barges account for a much larger share of petroleum product shipments. Most shipments of petroleum products via tanker, barge and pipeline occur between the Gulf Coast and Midwest and East Coast regions. According to the Association of Oil Pipelines (AOPL)[3], 74.8 percent (285 billion ton-miles) of all crude oil and 60.8 percent (306 billion ton-miles) of petroleum products were transported by pipeline in 2003. Water carriers accounted for 24.8 percent and 29.1 percent of the crude oil and petroleum products, respectively. Trucks and rail also contribute to this vast network but their overall contribution is relatively small.

Bulk storage facilities are located along transportation routes to accommodate the different rates at which transportation modes can handle oil and refined products. Storage facilities are also located at refineries and at wholesale and retail marketing facilities where products are stored prior to being sold to consumers. Collectively, the petroleum distribution system, consisting of all storage facilities and the various modes of transportation, hold the nation's inventories of available stocks of crude oil and refined petroleum products. Figure 6 shows 2005 end-of-year stocks for crude oil and the petroleum products addressed in this study—motor gasoline, distillate, jet fuel and propane—by stock type (i.e., location within the overall delivery system where the stocks reside), as reported by the EIA.

In addition to commercial stocks of crude oil and petroleum products, the nation also maintains two strategic reserve inventories. In response to the 1973-1974 oil embargo, Congress enacted the Energy Policy and Conservation Act in 1975 which called for establishing a Strategic Petroleum Reserve (SPR). The purpose of the SPR is to afford protection against a major disruption of crude oil supplies. The SPR is an emergency stockpile, for use at the President's direction in the event of a severe energy supply disruption, or to meet U.S. obligations as member of the International Energy Agency (IEA). In 1977, the federal government began purchasing crude oil and storing it in underground salt caverns in six locations in Texas and Louisiana. Drawdowns from the SPR for emergency purposes occurred in January 1991 at the start of the Persian Gulf War and in the fall of 2005, following Hurricane Katrina. The SPR currently holds 689 million barrels. Figure 7 shows U.S. primary stocks of commercial crude oil and petroleum products as well as stocks held within the SPR between 1970 and 2005.

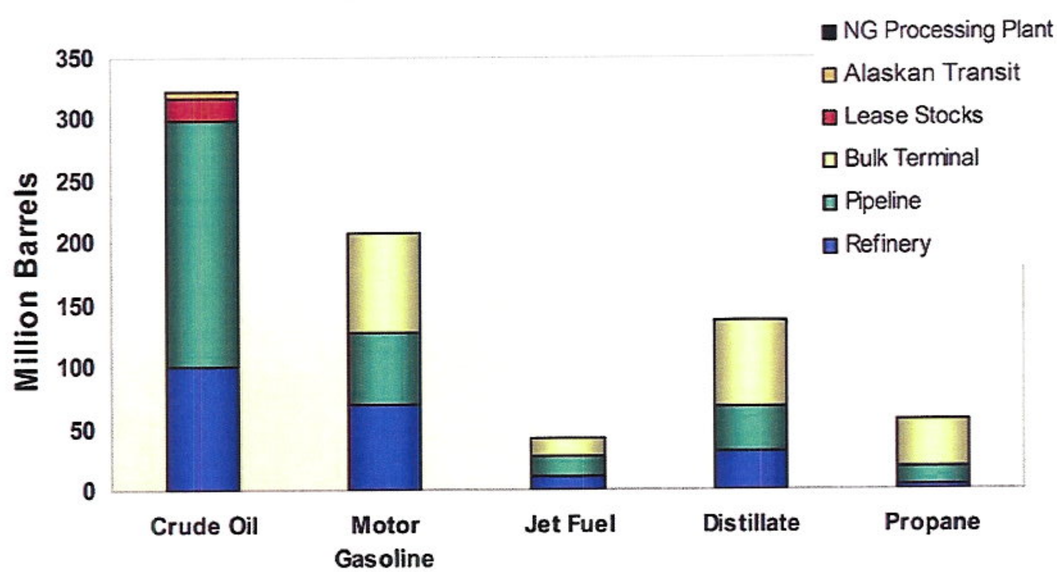


Figure 6. U.S. 2005 End-of-year Stocks, by Type *(Source: EIA)*

large diameter transmission pipelines and then through smaller diameter distribution pipelines to regional markets where it is either stored or directly consumed by end-users (Figure 9).

Pipeline systems provide natural gas to the major markets (e.g., northeastern United States, Chicago, and Florida) through transmission pipeline corridors extending from natural gas production areas to major market areas. The transmission pipelines have a finite capacity for transporting natural gas from supply sources. The wells in the producing regions of the country produce at a steady rate, while demand for natural gas generally varies on an annual cycle: higher in the winter and lower in the summer. However, this cycle is beginning to change somewhat due to the increase in gas-fired electric power generation in summer months for cooling purposes. Natural gas storage capacity, either in the producing regions or in the consuming regions, provides a way to meet demand during the peak season while maintaining a steady production rate. The volume of natural gas storage needed, particularly in regional markets, is growing with the overall growth in demand for natural gas.

Natural gas is primarily stored underground, although Liquefied Natural Gas (LNG) can be stored above ground. There are three major types of underground reservoirs used for storage: depleted gas or oil reservoirs, salt caverns, and aquifers (Figure 10). The type of storage within each region is based on local geology. Abandoned mines and mined caverns in hard rock regions are uncommon options. Depleted gas and oil reservoirs and aquifers are generally used for seasonal injection and withdrawal, where gas is injected into the storage reservoir during an injection period from April through October (214 days), and withdrawn during November through March (151 days). Injection rates are higher early in the injection season and taper off as the reservoir pressure increases. Withdrawal rates are similar in that the highest rates of withdrawal occur early in the withdrawal season and continually decrease through the heating season[4]. These seasonal reservoirs generally have the capability to support a high deliverability drawdown for 10 days during the withdrawal period. Salt cavern storage facilities have the capability of supporting multiple high deliverability drawdown and injection cycles. Most salt cavern storage facilities are designed to draw down in 10 days and

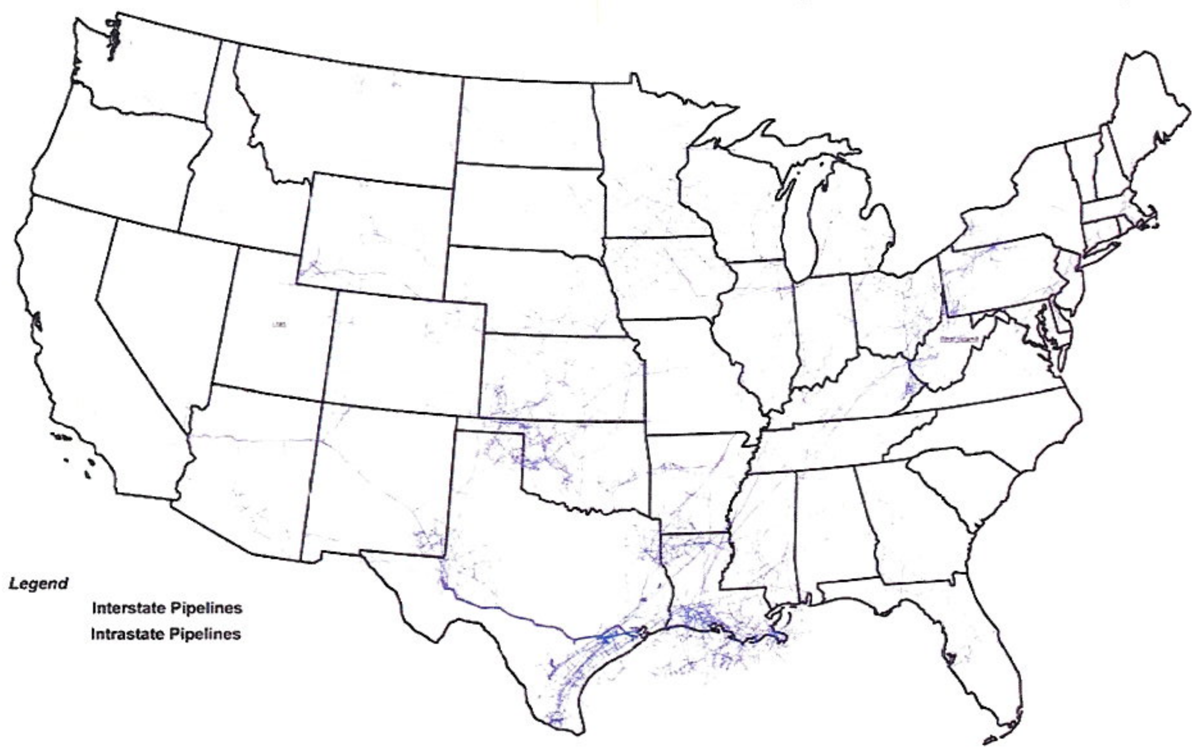


Figure 9. U.S. Natural Gas Pipeline Systems, 2005 *(Source: EIA, Gas Transportation Information System)*

gas capacity at 0.57 Tcf, and U.S. working gas capacity at 3.53 Tcf.

The 8.2 Tcf of natural gas storage capacity is located in 393 storage facilities in the lower 48 states. As shown in Figure 11, depleted reservoirs account for 80 percent of the storage; they are located throughout the western and southern United States and are the Northeast's most common type of reservoir. The majority of salt cavern natural gas storage is located in the Gulf Coast region, although several salt reservoirs are scattered throughout the Northeast and Midwest as well. Aquifer storage is clustered mainly in the north central region of the country, but a few reservoirs are located throughout the west. Due to the geology of the region, the New England region has no underground storage.

Of the total of 8.2 Tcf of storage capacity, depleted reservoir storage accounts for 6.8 Tcf or 82 percent of the capacity in 320 fields; aquifers account for approximately 1.2 Tcf or 15 percent in 43 fields; and high deliverability salt caverns total a little over 0.2 Tcf or 3 percent of the capacity in 30 fields (Figure 12)[6].

Natural gas storage serves as a supply for either base load demand or peak load demand. Base load storage is designed for long-term seasonal demand needs and is characterized by a net injection (i.e., injection into reservoir is greater than withdrawals) in the summer months and net withdrawals during the winter months. Depleted gas reservoirs are typically used as base load facilities. In contrast, peak load storage is designed to deliver high volumes of natural gas within a few days in the case of extreme weather or emergency situations. Salt cavern storage fields are often peak load facilities. Peak load facilities can have several injection and withdrawal cycles.

The cyclical operation of base load reservoirs is the result of seasonal demand; typically the largest

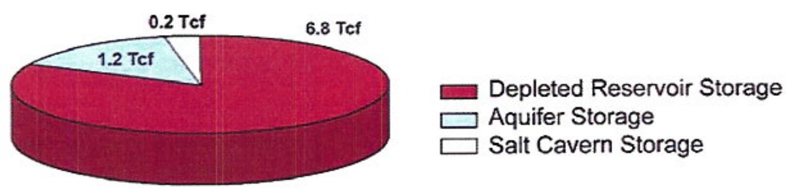


Figure 12. Total Storage Capacity by Underground Storage Types *(Source: 2004 EIA)*

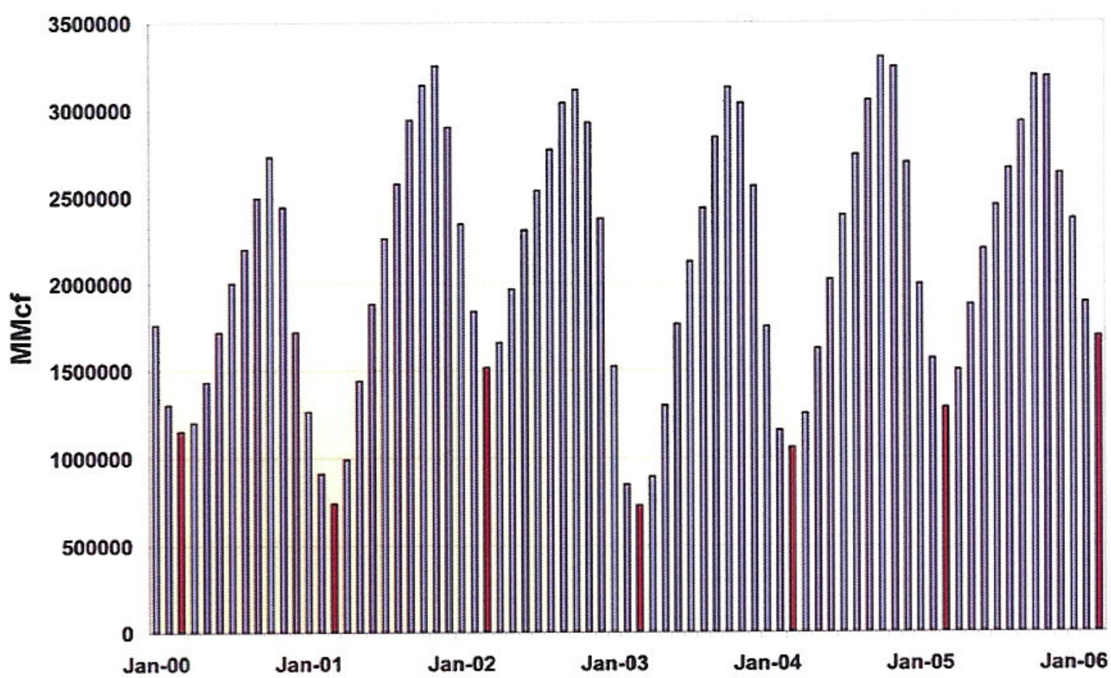


Figure 13. U.S. Total Working Gas from January 2000-2006 *(Source: EIA)*

Role of Inventory in Oil and Gas Supply Systems

Much of the crude oil, natural gas, and refined product held in inventory is necessary for the efficient operation of the respective supply and distribution systems. Above this minimum operating level, additional inventories are staged along the supply chain and serve a variety of roles. Operators seek to optimize their stock levels, balancing the cost of storing crude oil, refined products, or natural gas against the operational efficiencies holding an inventory may offer. Operators must also maintain sufficient supplies to ensure uninterrupted delivery in the face of fluctuating demand, both for seasonal and regional reasons.

Off-season storage of inventory serves as an economical method of supplying future demand versus a more timely purchase or production increase. Operators routinely build stocks of natural gas and heating fuels during the warmer months in order to meet the expected increased demand during the colder periods. Companies also build inventory in anticipation of planned maintenance (e.g., refinery maintenance). With respect to petroleum products, companies also build inventory of specific batches of fuel in order to comply with seasonal and regional product specifications. Product stockpiled for these reasons can be considered as a component of the overall supply, since this inventory is produced and stored in order to meet expected future demand.

Oil and natural gas stocks may further fluctuate around the optimum operational levels due to the current and future market values of these commodities. For example, if futures prices for delivery of oil or natural gas in coming months are higher than the current price, companies and investors may increase their inventory over the optimal operational level, anticipating the stockpiled product will be valued sufficiently in the future to offset the carrying cost and financial risks. When futures prices are lower than current prices, operators are more likely to maximize the sales of discretionary stocks they have accrued. An oil or natural gas supplier's primary focus still remains on providing its customers with product on demand, but prudent management of stock levels provides companies with the opportunity to create additional financial gains.

Finally, recognizing that the United States is dependent on international supplies of crude oil and refined products in particular, stocks may be built as a protection against a supply emergency driven by external factors. The SPR is the largest emergency stockpile of government-owned crude oil in the world, and provides the United States with a buffer of approximately 65 days worth of crude oil imports should a disruption in commercial oil supplies threaten the U.S. economy. It also allows the United States to meet part of its IEA obligation to maintain emergency oil stocks as well as providing a national defense fuel reserve.

Crude Oil and Petroleum Product Inventories and Industry's Ability to Meet Demand

Overview of Crude Oil and Petroleum Product Supply and Demand

Americans rely heavily on oil to meet their transportation energy needs. The nation's demand for oil is driven by the transportation sector, which currently consumes almost 14 million barrels per day (MMbpd). According to the EIA Annual Energy Outlook for 2006 (AEO2006 reference base case), by 2030, petroleum consumption is expected to increase to 28 MMbpd, maintaining its current share of 40 percent of total U.S. energy consumption (on a Btu basis). By 2030, petroleum for U.S. transportation needs is expected to rise to 20 MMbpd, approaching the current total U.S. oil consumption levels for all sectors of the economy (Figure 15).

Gasoline accounts for 44 percent of all petroleum consumption and it is projected to continue to do so into the future. Virtually all gasoline (98 percent) is consumed in the transportation sector and as shown in Figure 16, demand is expected to rise from current levels of 9.2 MMbpd to 12.5 MMbpd by 2030. The remaining two percent of gasoline is consumed in the commercial and industrial sectors for uses such as mining and agriculture. The most rapid increases in transportation fuel demand over the next 25 years are expected for freight movement and air travel. Demand for jet fuel, used exclusively in the transportation sector, is expected to increase by 1.4 percent annually, increasing from 1.6 MMbpd to 2.3 MMbpd. Unlike gasoline and jet fuel, distillates are used both as transportation fuels (e.g., low-sulfur diesel fuel, marine diesel) and as a heating and boiler fuel in the residential, commercial, and industrial sectors. Total distillate demand is expected to increase from 4.2 MMbpd to 6.1 MMbpd by 2030, an annual increase of 1.6 percent. This increase, driven by rising demand for diesel fuel in the transportation sector, is most notable given projected declines in distillate use as a home heating fuel as more homes move to cleaner, more convenient natural gas or in some cases, liquefied petroleum gases (LPG) such as propane.

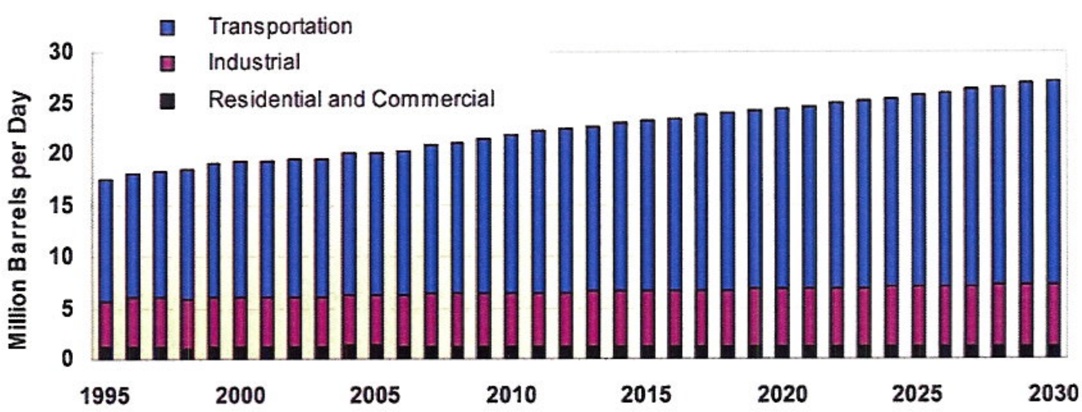


Figure 15. US Refined Petroleum Products Supplied by Sector *(Source: EIA)*

product quality requirements in California, the largest consuming state, the majority of the PADD's refined product demand is met by output from regional refineries, with minor volumes of refined products—predominantly finished motor gasoline and motor gasoline blending components—imported from PADDs III and IV.

Figure 17 shows the net domestic movement of crude oil and three major petroleum products—motor gasoline, distillate, and jet fuel—for the three most active PADDs for 2005. As described, PADD III is a net exporter, whereas PADDs I and II are net importers. PADD IV and V are not shown because of the relatively small volumes of crude oil and refined products that move in and out of these regions. Currently, PADD V is a net importer and PADD IV is a net exporter.

Historical Storage Capacity and Inventory Level Trends

The distribution system is typically divided into three sectors. The primary sector includes those elements of the system involved with the shipment and storage of crude oil, refining, and the delivery and storage of products in bulk wholesale terminals having at least 50,000 barrels of storage capacity. The secondary sector includes bulk marketing facilities having less than 50,000 barrels of storage capacity and retail outlets. These facilities generally receive their products by rail or truck. Final consumers comprise the tertiary sector. This sector includes, for example, industrial and residential users of fuel oil, freight company users of diesel fuel, and automobile leasing and rental company users of gasoline, and many others. Stock levels reported by EIA generally capture inventories at the primary level only due to the difficulty in collecting information at the retail level.

The following sections of the report review commercial crude oil and primary petroleum product inventories over a 10-year period, from 1995 through 2005. These inventories are compared to five-year rolling averages and to lowest operating inventory (LOI) estimates as used by the NPC[9]. The NPC defines LOI as the lower end of the demonstrated operating inventory range updated for known and definable changes in the petroleum delivery system. This definition and the LOI values used by NPC and in this report are consistent with those used by the EIA prior to November 2004[10]. However, inventories can be below the LOI and not experience supply shortages, and they can be above the LOI and experience supply shortages. Therefore, LOI is more useful as an historical frame of reference, rather than as indicative of a supply shortage.

Crude oil

Crude oil prices are determined by supply and demand conditions worldwide, and are notably influenced by production levels set by members of the Organization of Petroleum Exporting Countries (OPEC). Figure 18 shows monthly closing U.S. primary inventory levels for crude oil compared to the monthly average spot price for West Texas Intermediate. In January 2002, crude oil prices began a steady rise from a low in December

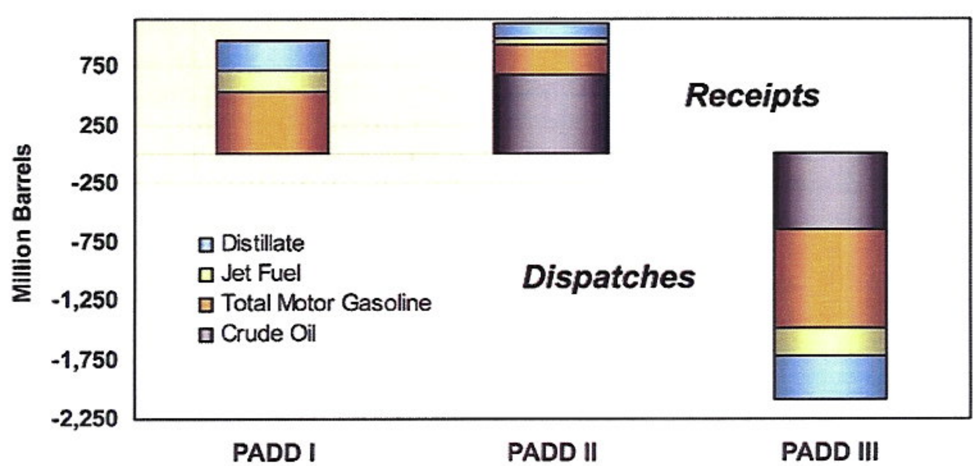


Figure 17. 2005 Net Movement of Crude Oil and Petroleum Products Among PADDs *(Source: EIA)*

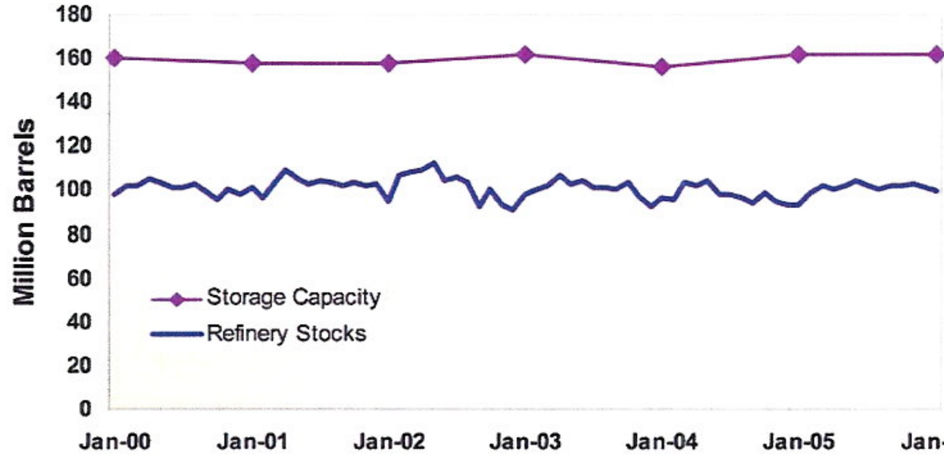


Figure 19. U.S. Refinery Crude Oil Working Storage Capacity and Stock Levels, 2000 – 2005[11] *(Source: EIA)*

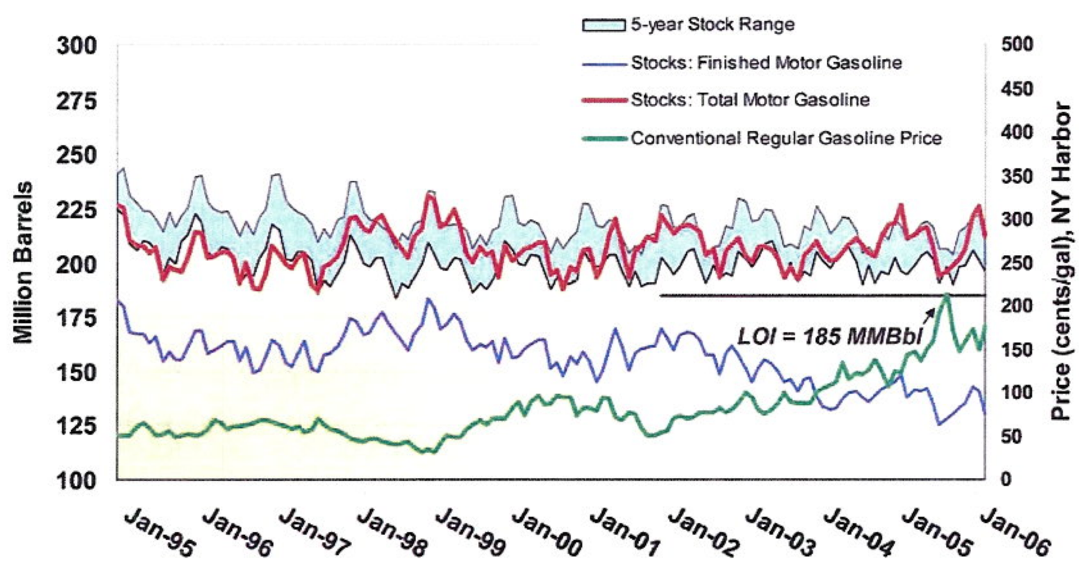


Figure 20. U.S. Motor Gasoline Inventories versus Spot Price at New York Harbor *(Source: EIA)*

been fairly constant over the past several years though some regional variation exists—PADD II is typically higher and PADD III typically lower. The remaining 220+/- million barrels of crude oil reported by EIA as primary inventory (excluding SPR) are crude oil stocks in transit or held at tank farms by pipeline companies and terminal operators for future distribution. A small portion of the stocks are also held by domestic crude oil producers at lease sites awaiting gathering and distribution (refer back to Figure 6).

Motor gasoline

The Federal Trade Commission review of recent gasoline price changes reports that under normal circumstances changes in crude oil prices account for approximately 85 percent of the variability of gasoline price. Historical data show that when crude oil prices change, there are commensurate changes in the price of gasoline. Figure 20 shows the monthly closing inventory levels for total motor gasoline compared to the monthly average spot price for regular gasoline at New York Harbor. In January 2002, driven by increases in crude oil prices, spot prices for gasoline began a steady rise from a low in December 2001 of $0.52 per gallon. While total motor gasoline inventories fluctuate seasonally, the rise in prices resulted in expected market behavior and a general decline in inventories. As with crude oil; however, this expected market reaction to higher prices has not been observed over the past two years. Instead, total motor gasoline inventories have and oxygenated gasoline blends. Today, there are a minimum of 15 different gasoline blends sold in the United States (excluding various octane grades). In order to accommodate delivery of these different fuels, refineries and bulk terminal operators must carry a wider variety of blending stocks. This requires additional storage capacity and places additional burden on the entire distribution system.

The decline in finished motor gasoline stocks has accelerated since 2004 (refer to Figure 20) as some states banned the use of the oxygen enhancing MTBE due to concerns related to groundwater contamination from leaking storage tanks. Because ethanol, the principal replacement for MTBE oxygenate, can not be transported in petroleum pipelines, additional blending stocks must be produced and shipped further downstream by rail or truck to bulk terminals nearer the end user where blending occurs.

This shift toward the storage of blending stocks can also be seen at the refinery level (Figure 22). As of January 2005, U.S. refineries maintained 138 million barrels of storage capacity for motor gasoline of all types. Though overall capacity has remained relatively stable over time, refineries have shifted from finished motor gasoline storage capacity to blending component capacity over the past decade. In addition, utilization of finished motor gasoline storage capacity has declined significantly over the past two years. This trend toward lower levels of finished motor gasoline inventories in lieu of blending component stocks can be observed in every region of the country (i.e., PADD) for both refineries and bulk blending terminals. Another possible reason for the observed trend is that refiners and bulk terminal operators have implemented cost-cutting practices for the management of inventories in order to reduce holding costs. However, during periods of tight supply or unexpectedly high demand, lower inventory levels resulting from these management practices can impede immediate delivery of product and thus, result in price increases.

The supply situation in the United States with respect to motor gasoline is characterized by increased reliance on imports. As domestic refinery capacity utilization rates have increased, refiners and marketers are turning more to foreign supplies to meet growing U.S. demand. Because foreign imports are traded in a global market, the prices paid for these incremental supplies can affect end-use prices in the United States regardless of the origin of the product. Figure 23 shows the growth in both finished motor gasoline and blending component imports since 1995. Much of these imports come from Europe where the high demand for diesel fuel has led to a surplus of gasoline production in the refining sector. Essentially, this entire product is imported into PADD I.

Distillate fuel oil

Distillate fuel oil is used primarily as a transportation fuel and for heating within the residential, commercial and,

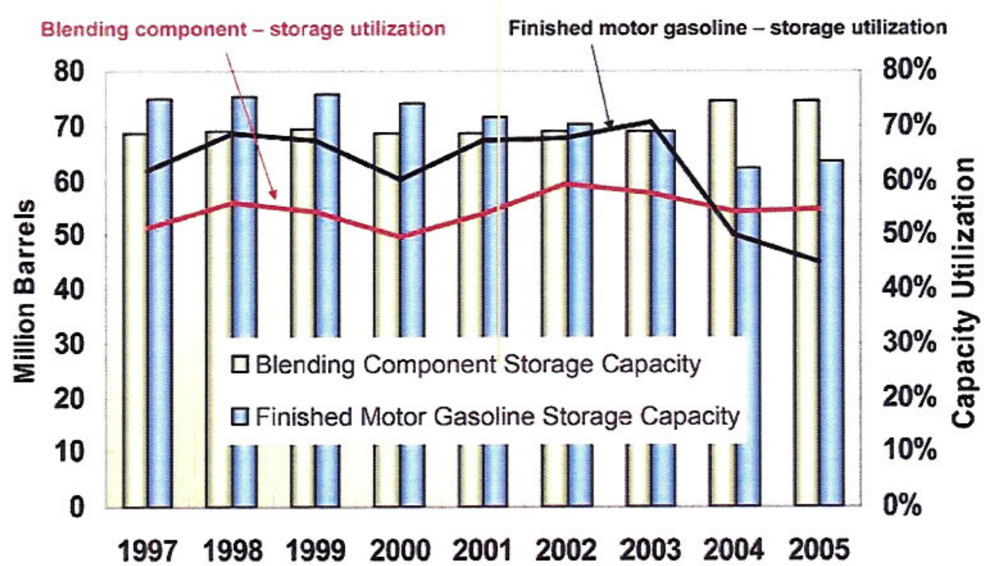


Figure 22. Refinery Storage Capacity and Capacity Utilization of Finished Motor Gasoline and Motor Gasoline Blending Components, 1997 through 2005 *(Source: EIA)*

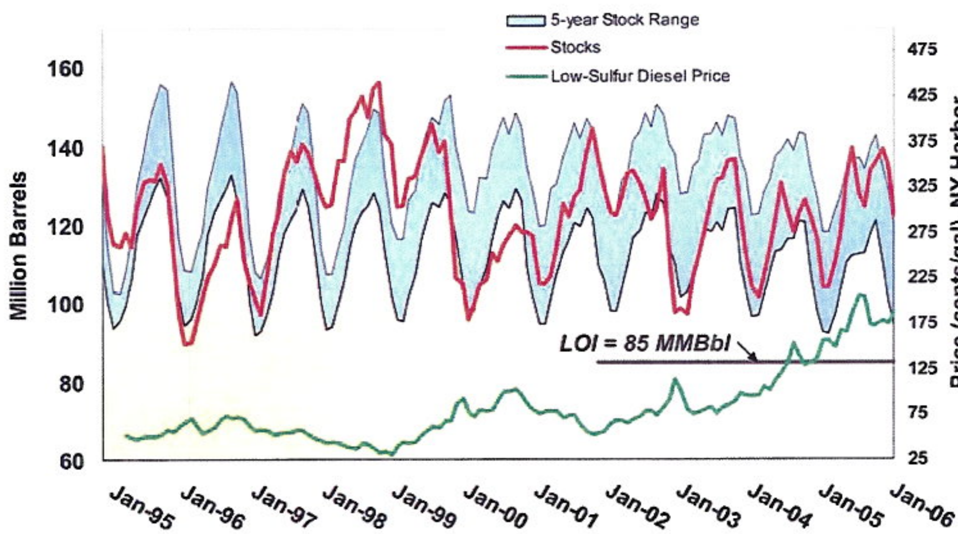


Figure 25. U.S. Distillate Fuel Oil Inventories versus Spot Price at New York Harbor *(Source: EIA)*

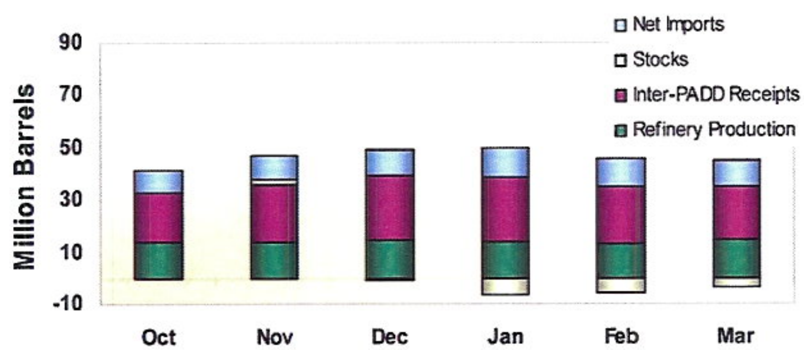


Figure 26. Sources of PADD I Distillate (Heating Oil) Supply, 5-Year Average October – March *(Source: EIA)*

For homes and businesses that rely on heating oil, the possibility of severe weather is addressed by stocks, transfers, and imports. Nationally, the supply of heating oil has been remarkably dependable. Because of PADD I dependence on heating oil and its limited indigenous refining capacity, winter supplies must be met by a combination of regional stock drawdowns, inter-PADD transfers and imports from other countries. Figure 26 shows how distillate demand has been met in PADD I on average over the past five winter heating seasons. In extreme circumstances, additional distillate fuel oil can be made available from the Northeast Heating Oil Reserve (NHOR). Although market dislocation trigger effects have occurred several times, there have as yet been no drawdowns from the NHOR[13]. As shown in Figure 27, PADD IA[14] primary stocks (excludes the NHOR)over the past two winter seasons have been well within the five-year average range.

Sixty-eight percent of all distillate used in the United States is for transportation purposes. Due to increased air quality concerns, the Environmental Protection Agency (EPA) has mandated new ULSD requirements that go into effect in 2006. These new regulations are expected to significantly reduce nitrous oxide and particulate matter emissions to the atmosphere from on-road diesel vehicles. Under these new rules, the maximum allowable sulfur content of on-road diesel fuel will be reduced from 500 parts per million (ppm) sulfur down to 15 ppm sulfur. Initially, 80 percent of the on-road diesel supplied by refiners and importers must meet the 15 ppm ULSD standard. By 2010, all on-road diesel fuel will need to be ULSD compliant. EPA estimates that the sulfur reduction requirement will increase the cost of diesel fuel by about five cents per gallon.[15]

relief, prices dropped and inventories began to rebuild. By January 2006, inventories were at 45 million barrels, a level not seen since December 2000.

Propane

Propane is a by-product of refining operations and natural gas processing. As such, domestic production of propane is dictated by natural gas and petroleum product demand. Figure 29 shows monthly product supplied data for propane as well as production volumes from refining and natural gas processing. Propane prices generally move with crude oil prices but because of its use as a winter heating fuel, seasonal weather-related price swings do occur. In addition, because different sectors compete for propane, price movements can be exaggerated. A major reason for these price swings is due to the fact that propane is produced at a relatively steady rate throughout the year and therefore no ready source of incremental production is available when supplies run low. When supply/demand imbalances occur, inventories from storage and product imports, largely from Canada, must augment domestic supplies.

March through September is the stock building season due to the much lower demand for propane during the summer months. Stocks have ranged well within the 5-year average and have not fallen near the LOI estimate of 18.5 million barrels in the past 10 years.

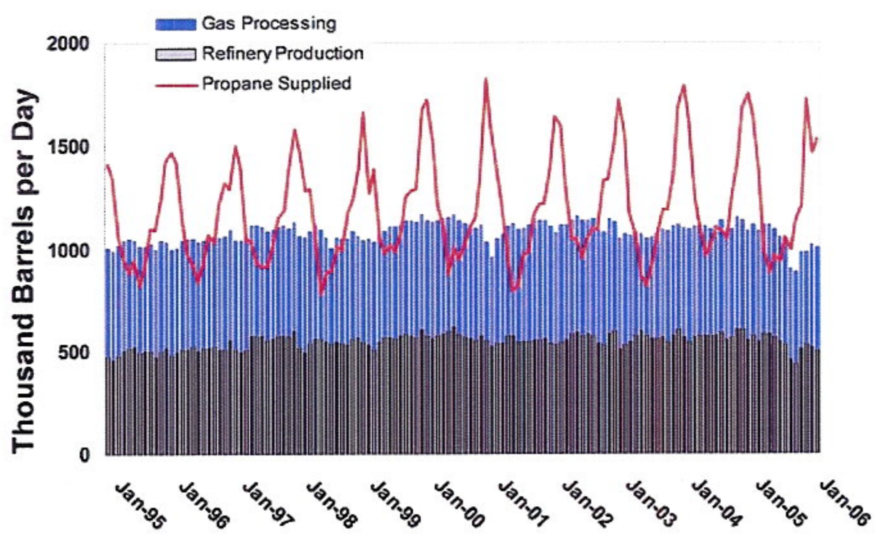


Figure 29. U.S. Propane Production and Volume Supplied *(Source: EIA)*

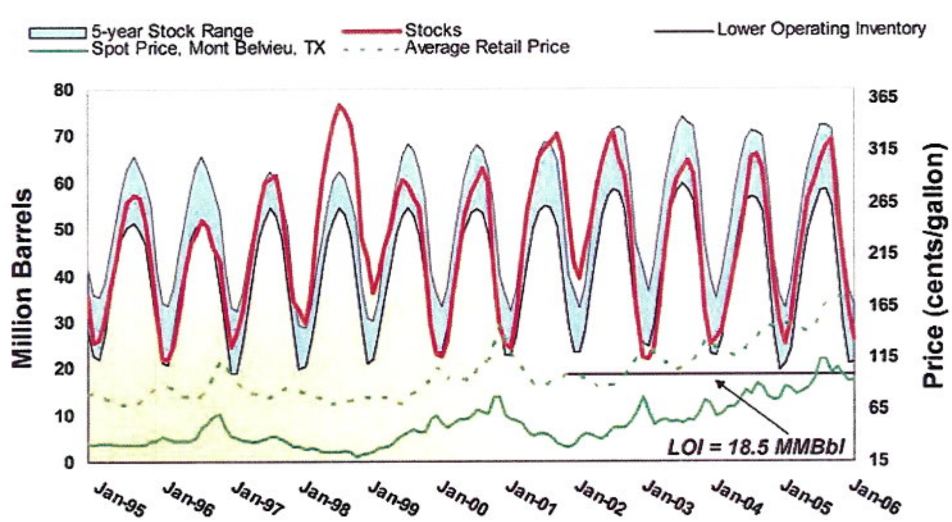


Figure 30. U.S. Propane Inventories versus Spot Price at Mont Belvieu, TX and Average Retail Price *(Source: EIA)*

Table 2. Number of Days Covered by Inventory for Total Petroleum Imports and U.S. Consumption, and Crude Oil Inputs to Refineries

	Imports	Petroleum Consumption	Refinery Inputs[a]
Commercial Stocks & SPR	129	82	65
Commercial Stocks	77	49	21

[a] Refinery Inputs of Crude Oil Only
Source: EIA

transports crude oil from Louisiana to Illinois, was shut down for several weeks. The Colonial Pipeline, which transports petroleum products to the East coast, experienced service outages and reduced throughput causing short-term price spikes in the Mid-Atlantic and Northeast regions.

Refinery operable utilization rates continue to be high (Figure 32). Inventories appear adequate in the short-run, and though refiners have limited ability to respond to significant supply shortfalls, imports are now positioned to respond in their place. Refiners can address this situation by increasing their inventory levels and by relying on imports. Thus, refiners and marketers are increasingly relying on finished product imports, principally from Europe, to augment domestic supplies. Not all foreign refineries have the capacity to produce finished products to the stringent specifications required of U.S. markets, so the augmentation of domestic supplies with foreign supplies when foreign supplies offer a lower cost alternative is only applicable to those foreign supplies that meet regional or local specifications. Increased levels of imported products have a number of market implications, including:

- Supply of imported products can be adjusted to compensate for domestic supply disruptions. Imported products (and crude oil) are, like domestic products, subject to supply disruptions which can affect their short-term availability to the United States, though the strong international market means that significant long-term disruptions are extremely unlikely.
- Imported products must be transported farther than domestically produced fuels so when supply disruptions occur in the United States, prices can rise until the imported supplies reach the market.

Product specifications also affect production and distribution of products domestically. Prior to 1990, gasoline was distinguished by octane grade—regular, midgrade, and premium—and summer/winter volatility restrictions. Today, as a result of the Clean Air Act Amendments of 1990, three distinct formulations of gasoline exist—conventional, oxygenated, and reformulated. Each of these formulations is available in three grades with volatility distinctions between northern/southern states and summer/winter blends.

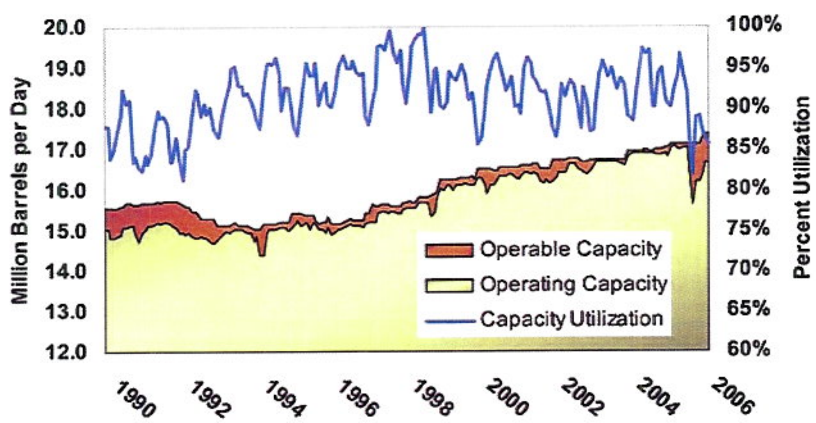


Figure 32. Historical U.S. Refining Capacity and Utilization *(Source: EIA)*

Natural Gas Inventory Levels and Industry's Ability to Meet Demand

Overview of Natural Gas Supply and Demand

As with oil, Americans rely on natural gas to meet their overall energy needs. Consumption of natural gas is distributed among four sectors: residential heating, cooling and cooking (24 percent); commercial heating, cooling and cooking (15 percent); industrial use (34 percent), and electrical power generation (27 percent)[17].

Industrial applications include those same uses found in residential and commercial settings, plus a wide range of other uses, from waste treatment to glass manufacturing to food processing. Natural gas is also used as a feedstock for the manufacture of petrochemicals, basic organic chemicals, and products such as fertilizers and pharmaceuticals. Industrial and commercial consumers rely on natural gas to fuel very efficient combined cooling, heat, and power (CCHP) systems, where gas is used to generate the electricity needed in a particular industrial setting and the excess heat and steam produced from this process are harnessed to fulfill other industrial applications.

According to the EIA, Annual Energy Outlook for 2006 (AEO2006 reference base case) total natural gas consumption is expected to increase from 22.4 Tcf in 2004 to 26.9 Tcf in 2030 (Figure 34). One result of

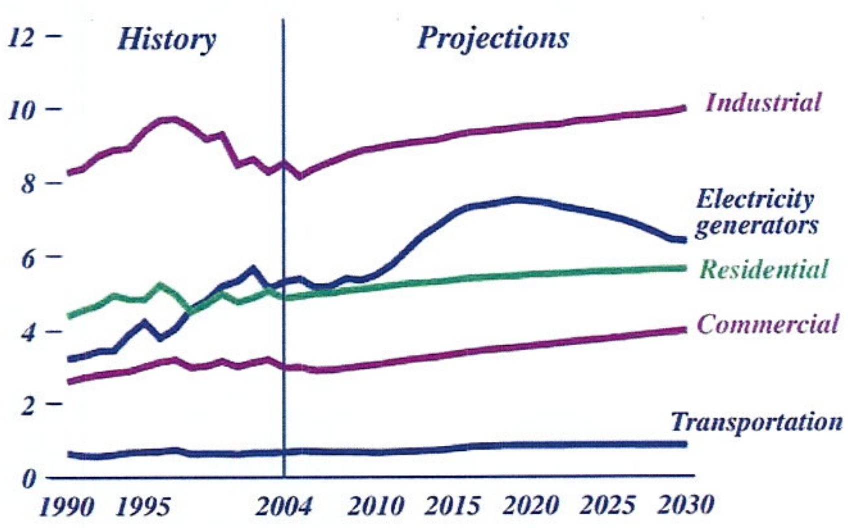


Figure 34. U.S. Natural Gas Consumption by Sector (Tcf) *(Source: EIA)*

Historical Natural Gas Storage Capacity and Inventory Level Trends

Total U.S. natural gas storage capacity, and most importantly the volume of working gas, has remained essentially unchanged since the mid 1980s. Figure 36 shows the growth in U.S. natural gas demand (including the forecast to 2030) compared to the volume of working gas in underground storage in October (generally a peak month) of each year. In 2005, FERC Chairman Joseph T. Kelliher said, "Since 1988, gas storage capacity has expanded only 1.4 percent, while natural gas demand has risen 24 percent"[21]. Availability of imports to meet demand, and improved storage management practices affect the need for growth in storage to respond to growth in demand. To better understand the range and long-term adequacy of regional total storage capacities, an evaluation was conducted for eight of the nine census regions using data through the end of the 2005 injection season (October 2005) with the maximum amount of working gas injected.

The analysis shows that in five of the eight regions, total storage levels (working gas plus base gas) approach the total storage capacity value, with the Mountain West, East North Central, and West South Central Regions having the largest volume of unused capacity remaining (Figure 37). Coincidently, the two regions that have significant remaining capacity (West South Central and Mountain) are the dominant producing regions with established pipeline infrastructure. The largest volume of total storage capacity is in the East North Central Region and the lowest is found in the East South Central Region. Although some unused storage capacity remains in every region, the smallest volumes are in the East South Central, West North Central, and Pacific Regions.

The total unused storage capacity as of the end of October 2005 based on total design capacity was approximately 800 Bcf (Figure 37). Unused capacity by region as a share of working gas capacity ranged up to 64 percent in the Mountain Region[22]. The unused capacity indicates the capability for additional gas to be added to storage without further capacity additions, although it is unlikely that the facilities would hold an amount close to the total design capacity. Factors constraining working gas stocks below 100 percent utilization include the need of reserve capacity for the pipelines and LDCs to meet operational requirements on their systems and arbitrage activities by holders of capacity rights, especially at high-performance facilities.

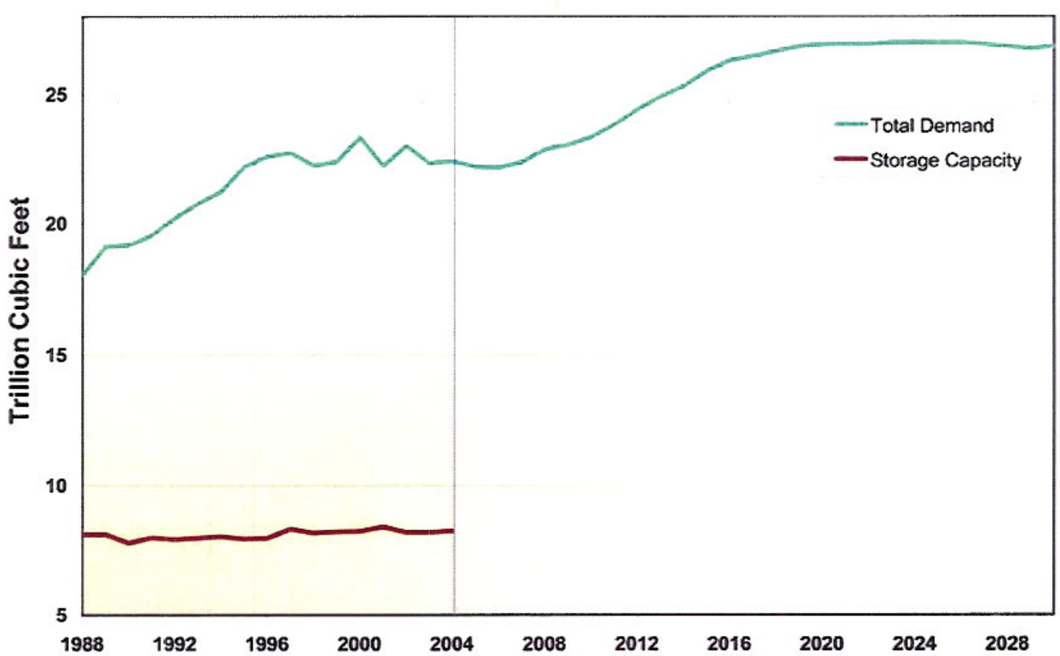


Figure 36. U.S. Natural Gas Demand and Underground Storage Capacity, 1988 to 2030
(Source: EIA, AEO2006)

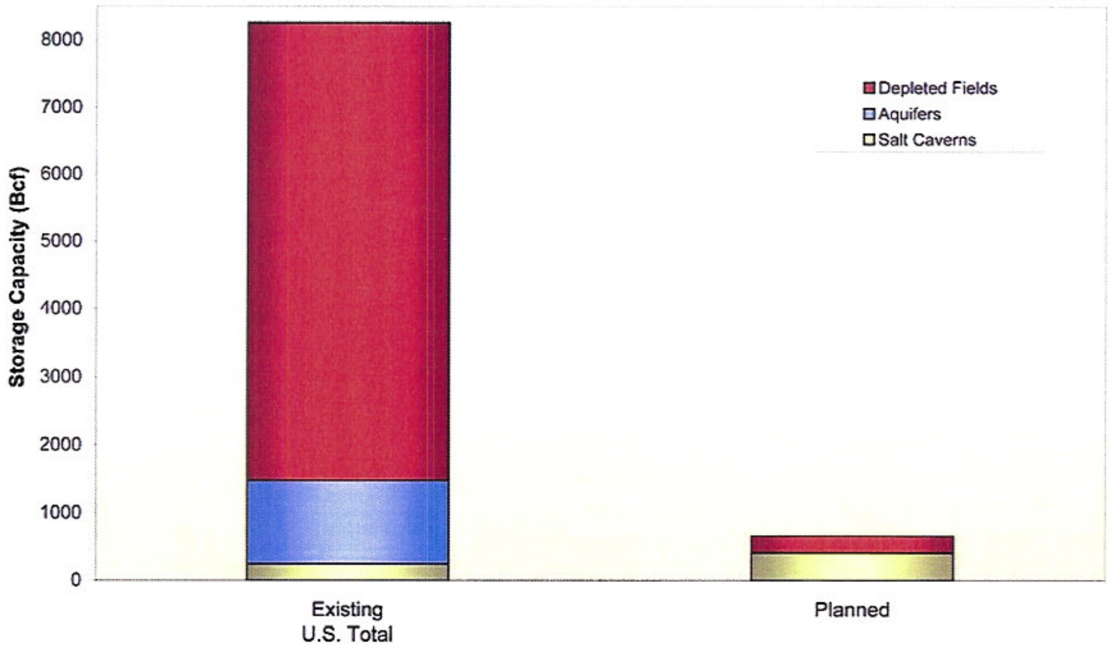


Figure 38. Existing and Planned Total Storage Capacity by 2010
(Source: Platts 2005 update)

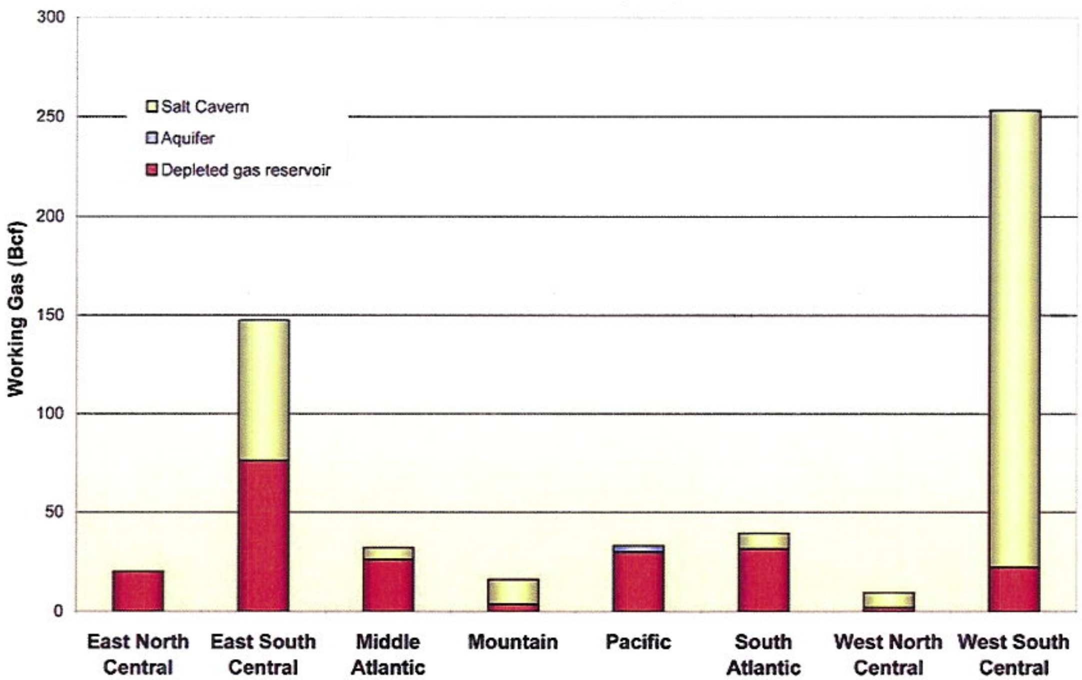


Figure 39. Regional Planned Storage by 2010 *(Source: Platts 2005 update)*

In addition to the additional storage capacity volumes proposed for various regions, there exists a certain amount of storage capacity that remains unused within each region in a given season. Historical natural gas storage inventories have been analyzed on a regional basis by plotting the variation in working gas levels with time, compared to a working gas band that represents the range over five prior years. Plots were also made displaying the total gas storage capacity level, base gas level, and fluctuating working gas level over time, also on a regional level. Eight of the nine regions are represented with graphical displays (the New England region does not have any underground storage to analyze).

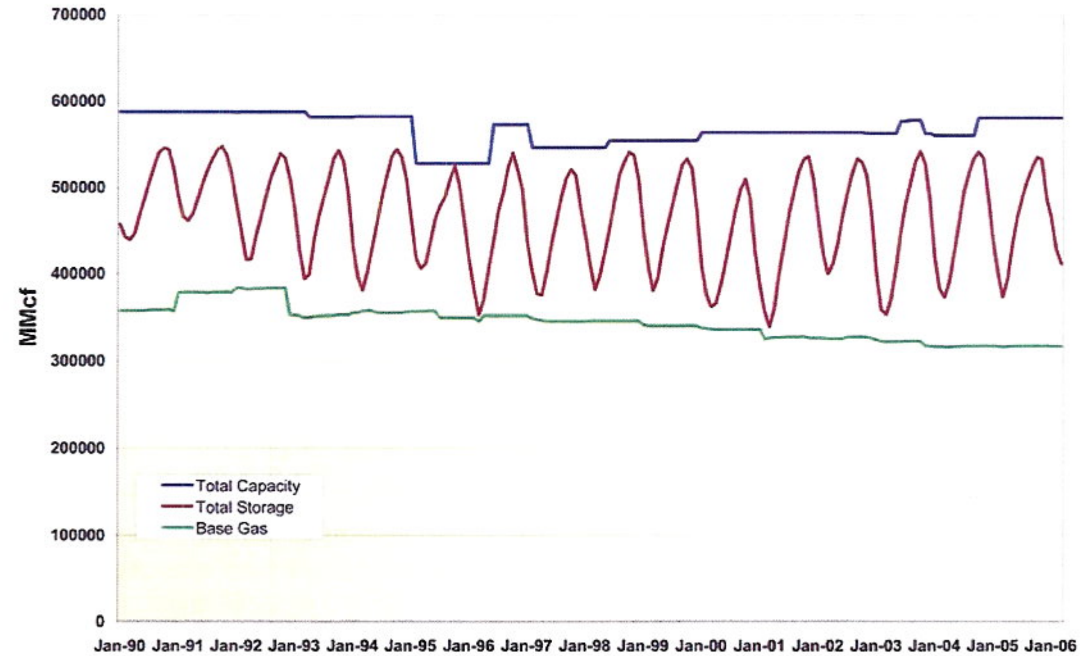


Figure 41. Historical Trend for South Atlantic Region–working gas level compared to total capacity and base gas *(Source: EIA)*

These are worst case scenarios. Evaluation of historical data has indicated that natural gas inventories have been low a number of times, each one corresponding to extreme weather events during the heating season.

The natural gas supply disruption from hurricanes Katrina and Rita occurred late in the injection cycle when working gas inventories were near their maximum. Also, there was a decrease in natural gas demand resulting from petroleum refineries and chemical plants being out of service in the Gulf region. The decrease in demand allowed injection to continue and inventories were able to reach a "normal" level prior to the heating season. Hence, at the end of the 2006 heating season, storage inventories did not drop below normal ranges even though a supply disruption occurred.

If industry determined it needed enhanced flexibility in the natural gas supply and infrastructure as well as better utilization of current storage reservoirs, the following two options could create flexibility in mitigation of regional supply uncertainty during times of low inventories:

Table 3. Days of Regional Supply Remaining Before Working Gas Would Have Been Depleted for Selected Seasons *(Source EIA)*

	Middle Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific
Winter 2000-2001	10 days	12 days	7 days	2 days	17 days	14 days	13 days	12 days
	(9.3 Bcf/d)	(17.4 Bcf/d)	(6.2 Bcf/d)	(6.4 Bcf/d)	(4.2 Bcf/d)	(12.8 Bcf/d)	(4.2 Bcf/d)	(7.0 Bcf/d)
Winter 2002-2003	9 days	9 days	7 days	5 days	12 days	14 days	20 days	15 days
	(10.8 Bcf/d)	(18.4 Bcf/d)	(6.3 Bcf/d)	(6.8 Bcf/d)	(4 Bcf/d)	(12.6 Bcf/d)	(3.7 Bcf/d)	(6.7 Bcf/d)
Winter 2006-2007	10 days	12 days	7 days	2 days	19 days	16 days	13 days	10 days
	(9.9 Bcf/d)	(17.4 Bcf/d)	(6.0 Bcf/d)	(6.4 Bcf/d)	(3.6 Bcf/d)	(11.0 Bcf/d)	(4.2 Bcf/d)	(8.0 Bcf/d)

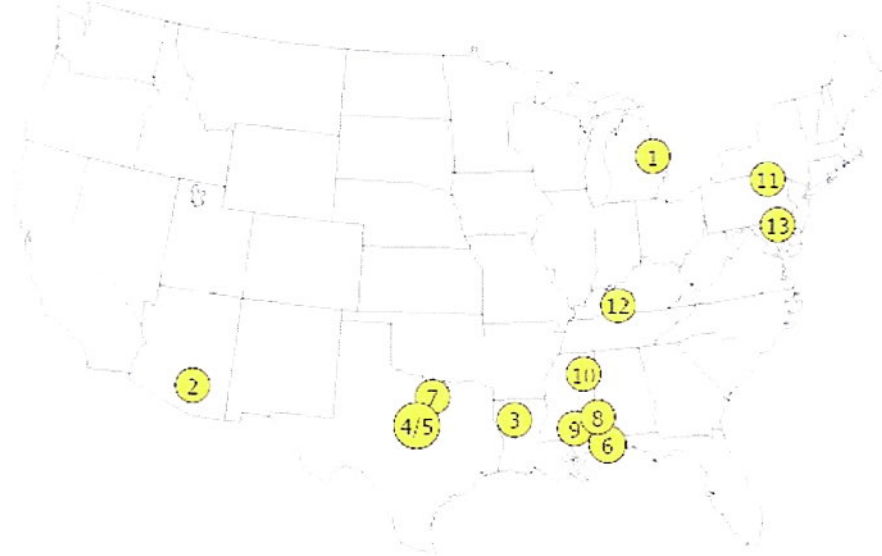


Figure 42. Major Storage Projects on The Horizon, May 2006 *(Source: FERC)*

Table 4. Major Storage Projects on the Horizon (as of May 2006) (Source: FERC)

	Project (Company)	Deliverability (MMcf/d)	Capacity (Bcf)
*1	Bluewater Gas Storage LLC	700.00	27.00
**2	Copper Eagle Salt Cavern Storage	320.00	3.20
3	EnCana Gas Storage	400.00	8.00
4	Hill Lake-Phase II	300.00	10.40
5	Worsham-Steed Gas Storage Project Phase II	220.00	12.00
6	MoBay Storage Phase I	300.00	20.00
7	Worsham-Steed Gas Storage Project-Phase I	100.00	8.00
8	County Line Storage Project	600.00	6.00
9	Petal Gas Storage, LLC	500.00	5.00
10	Caledonia Energy Partners, LLC	330.00	1.70
11	SemGas LP	300.00	5.50
12	Midland Storage Field Expansion	90.00	6.80
13	Eastern Expansion Project	270.00	16.40

* Completed in 2004

** Currently on hold by El Paso

natural gas from producing regions to consuming markets in the lower 48 states.[27] Based upon current inventory of permitted natural gas pipeline expansion projects, the level of pipeline construction activity in the United States is forecasted to increase substantially between 2007 and 2010. More than 180 pipeline projects, representing a potential 11,300 miles of new large-diameter pipeline and 116 Bcf of capacity have been approved by U.S. regulatory authorities. If all the projects were actually completed, 4 percent more pipeline miles would be added to the national grid and overall network capacity could increase by more than 50 percent (Table 5). Additional pipelines are already in the planning stages for areas such as the Rockies. The Rockies Express Pipeline (1,323 miles) will transport 1.8 Bcfd to eastern Ohio from Colorado and Wyoming, thus creating an additional supply source directly from the Rockies to the eastern United States.[28] Additionally,

Summary and Findings

Crude Oil and Petroleum Products

The U.S. storage and distribution system for crude oil and petroleum products is robust, responding remarkably well to market price signals. However, under extreme conditions such as those experienced during the twin hurricane disasters of 2005 potential supply problems can occur, especially at a regional level. Globalization of crude oil and petroleum product markets can provide relief for domestic supply disruptions, but dependence on imports comes with its own supply risks.

This report has analyzed the U.S. crude oil and petroleum product storage capacity to determine whether historic and future inventory levels are adequate to meet demand without unusual shortages or price spikes. Key findings include:

- Over the past 10 years, spot prices for conventional motor gasoline and distillate have tracked closely with crude oil prices. Noticeable spikes in product prices have occurred due to extreme supply dislocations such as those experienced in 2005 as a result of hurricanes Katrina and Rita.
- Crude oil prices are the primary determinant of finished petroleum product prices, but other factors can influence product prices, such as available refining capacity, inventory levels, and regional or local product specifications.
- The emergence of the futures market has served to help achieve efficient allocation of resources.
- Inventories of crude oil and the major petroleum products have generally been well within their five-year averages and, in late 2005/early 2006, they exceeded inventory levels for the same period (i.e., month) over the last several years.
- Since 2004, inventories have been on an upward trend despite a continuous rise in prices, suggesting stockpiling resulting from concerns of upstream constraints or other potential supply disruptions and further increases in prices.
- Though total motor gasoline stocks have generally risen, finished motor gasoline stocks have declined relative to blending component stocks. Variations in motor gasoline formulations and the increased use of ethanol as a replacement for MTBE have contributed to this trend.
- Disruptive events such as last year's hurricanes provide insights into the importance of inventories—both domestic and OECD—and the need for a robust delivery system.
- Private sector investment in new refining, storage and distribution infrastructure will be difficult and costly, but would facilitate continued system reliability and minimize supply disruptions.

As future demand for petroleum rises and domestic crude oil production remains flat or declines, oil imports may increasingly be the low-cost supply. Currently, about two-thirds of all U.S. crude oil imports come from Canada, Mexico, Venezuela, Nigeria, and Saudi Arabia. Despite forecasts of future production growth, Saudi Arabia has yet to demonstrate an intention to ramp up production beyond its 1980 peak of 10 million barrels per day. Canada is in a position to significantly increase oil exports. Canadian Athabasca oil sands production and downstream refining is scheduled to double over the next 10 years, bringing total production to 2.2–2.4 million barrels per day. Currently, there are 22 identified ongoing development and expansion projects and 24 that are proposed. The total planned cost for the ongoing projects is $32.3 billion ($C) and the total planned cost for the proposed projects is $37.5 billion ($C).[29] Over the next decade, additional crude oil is likely to come from Canada as segregation between different products requires more facilities and additional capacity, which adds to the overall cost of the commodity. Product differentiation regionally and seasonally has led to growing pressure on the transmission, distribution, and storage system.

The ability of industry to expand the refining, storage, and liquid pipeline network and to update the aging infrastructure will be challenged. Increasing urbanization, environmental expectations, tolerance for siting of industrial facilities, and development of new technologies to address compliance issues will all affect permitting and acquisition of plant sites and pipeline rights-of-way.

Natural Gas

Natural gas demand is projected to be strong in the future. In 2004, consumption was approximately 22.4 Tcf and is projected to increase over the next 25 years to 26.9 Tcf. Natural gas demand currently is and will continue to be met by a combination of domestic supply and imports through pipelines from Canada and LNG receiving terminals. The private sector will need to develop additional natural gas storage in order to meet the seasonal demand increases for base load gas supply during the winter heating season and for summer cooling. Also, gas storage will be called on to provide peak load natural gas for gas-fired power plants during the summer cooling months.

U.S. total storage capacity at the end of 2004 was approximately 8.2 Tcf, and total storage inventories, consisting of working gas and base gas, were 7.5 Tcf at the beginning of the heating season (November 1). The majority (75 percent) of working gas capacity is located in depleted reservoirs; aquifer and salt cavern storage make up the remaining volume. Natural gas storage inventories are currently at the level required to meet today's seasonal demand and investments are currently being made to meet future seasonal demand. New natural gas underground storage and infrastructure is currently being planned and implemented by Industry to meet the future requirements. Support for additional investment in new storage comes from the Energy Policy Act of 2005, Section 312, which authorizes the FERC to permit market based rates for new storage facilities. However, one caveat is that the New England region, without underground storage, relies on LNG import terminals and satellite LNG facilities for approximately 30 percent of winter daily peak supply and 20 percent of total supply.

This report has analyzed the U.S. natural gas storage and delivery system to determine whether historic and future inventory levels are adequate to meet demand without unusual shortages or price spikes. Key findings include:

- End of heating season storage levels have been increasing over the past three years. There were approximately 407 Bcf more gas in storage at the end of the 2006 heating season (March 2006) than in 2005, and 633 Bcf more than in 2004. This gradual increase can be attributed to milder than normal winters over the past few years.
- In the last five years, working natural gas levels have been within the five-year rolling average "working natural gas band." There are several instances when the working gas level fell to a point close to or outside the working gas band. On a regional level; however, the storage inventories did not dip below the base gas level, indicating that while the levels of inventory may occasionally dip, there are significant amounts of working gas available.
- Storage inventories are currently above the five-year rolling average. Since January 2002, the price of natural gas has fluctuated in an upward trend that is primarily due to flat or decreasing domestic supply and increasing demand.
- Reservoir engineering and regulatory factors constrain working gas stocks below 100 percent utilization. In addition, storage operators hold reserve capacity for the pipelines and local distribution companies (LDCs) to meet operational requirements on their systems and arbitrage activities by holders of capacity rights.
- Regional analysis of storage inventories and growth in demand indicate that the West North Central and the South Atlantic regions have limited spare storage capacity, few plans for adding storage capacity, and yet represent two of the three regions with largest expected annual growth rate in natural gas demand.

Acronyms

AEO2006	EIA Annual Energy Outlook for 2006
AGA	American Gas Association
AOPL	Association of Oil Pipelines
Btu	British thermal unit
CaRFG	California Reformulated Gasoline
CCHP	Combined Cooling, Heat, and Power
CERA	Cambridge Energy Research Associates
EIA	Energy Information Administration
EPA	Environmental Protection Agency
EPAct	Energy Policy Act of 2005 (EPAct)
FERC	Federal Energy Regulation Commission
GDP	Gross Domestic Product
GOM	Gulf of Mexico
IEA	International Energy Agency
INGAA	Interstate Natural Gas Association of America
LDCs	local distribution companies
LNG	liquefied natural gas
LOI	lowest operating inventory
LPG	liquid propane gas, or liquefied petroleum gases
MTBE	methyl tertiary butyl ether
NHOR	Northeast Heating Oil Reserve
NG	natural gas
NGSA	Natural Gas Supply Association
NOAA	National Oceanic and Atmospheric Administration
NOPR	Notice of Proposed Rulemaking
NPC	National Petroleum Council
OECD	Organization for Economic Co-operation and Development
OCS	Outer Continental Shelf
OPEC	Organization of Petroleum Exporting Countries
PADD	Petroleum Administration for Defense District
RBOB	Reformulated gasoline Blendstock for Oxygen Blending
SPR	U.S. Strategic Petroleum Reserve
ULSD	ultra-low-sulfur diesel
WG	working gas

million barrels per day (MMbpd)
million cubic feet (MMcf)
million cubic feet per day (MMcf/d)
billion cubic feet (Bcf)
billion cubic feet per day (Bcf/d)
trillion cubic feet (Tcf)
parts per million (ppm)

Definitions

Petroleum Concepts

Petroleum: A broadly defined class of liquid hydrocarbon mixtures. Included are crude oil, lease condensate, unfinished oils, refined products obtained from the processing of crude oil, and natural gas plant liquids.

Crude oil: A thick, dark brown or greenish liquid fossil fuel. It consists of a complex mixture of various hydrocarbons.

Petroleum products: Petroleum products are obtained from the processing of crude oil, natural gas, and other hydrocarbon compounds. Petroleum products include unfinished oils, liquefied petroleum gases, pentanes plus, aviation gasoline, motor gasoline, naphtha-type jet fuel, kerosene-type jet fuel, kerosene, distillate fuel oil, residual fuel oil, petrochemical feedstocks, special naphthas, lubricants, waxes, petroleum coke, asphalt, road oil, still gas, and miscellaneous products. Common petroleum products include:

- **Diesel**: A fuel composed of distillates obtained in petroleum refining operations or blends of such distillates used in motor vehicles.
- **Ultra-low-sulfur diesel**: A new EPA standard for the sulfur content in diesel fuel sold in the United States beginning in 2006. This applies to all diesel fuel sold for use in road going vehicles. The allowable sulfur content (15 ppm) is much lower than the previous U.S. standard of 500 ppm.
- **Distillate fuel oil**: Fuel oil is obtained from petroleum distillation, and is classified into six classes, according to its boiling temperature, composition, and purpose. No.'s 1, 2, & 4 fuel oils are referred to as distillate fuel oils.
- **Gasoline**: A refined petroleum product. It is composed of a complex mixture of relatively volatile hydrocarbons with or without small quantities of additives, blended to form a fuel suitable for use in spark-ignition engines. Motor gasoline includes conventional gasoline; all types of oxygenated gasoline, including ethanol; and reformulated gasoline, but excludes aviation gasoline.
- **Jet fuel**: A refined petroleum product used in jet aircraft engines. It includes kerosene-type jet fuel and naphtha-type jet fuel. Jet fuels are produced by blending straight-run distillate components.
- **Propane**: Is derived from other petroleum products during oil or natural gas processing. It is commonly used as a heat source for engines, barbecues, and homes. When commonly sold as fuel, it is also known as liquefied petroleum gas.

Boutique fuels: Refers to any number of unique fuel blends sold in various regions of the country.

Natural Gas Concepts

Natural gas: Natural gas is a combustible mixture of hydrocarbon gases. While natural gas is formed primarily of methane, it can also include ethane, propane, butane, and pentane. In its purest form, such as the natural gas that is delivered to your home, it is almost pure methane. Methane is a molecule made up of one carbon atom and four hydrogen atoms, and is referred to as CH4.

Liquefied Natural Gas (LNG): LNG is natural gas in its liquefied form. LNG has been processed to remove impurities and heavy hydrocarbons and is 85 to 95+ percent methane. It is condensed into a liquid at atmospheric pressure by cooling it to approximately -260° Fahrenheit or -163° Celsius. This process reduces its volume by more than more than 600 times, allowing for efficient transport via LNG tanker.

Bishop Process: A novel method of unloading and re-gasifying LNG directly from LNG ocean tankers for natural gas storage in underground salt caverns.

Reservoir: An underground accumulation of petroleum or natural gas.

Strategic Petroleum Reserve (SPR): A series of underground storage caverns for crude oil stocks maintained by the federal government for use during periods of major supply interruption.

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Endnotes

[1] **Energy Policy Act of 2005, TITLE III – OIL AND GAS, Subtitle B- Natural Gas, SEC. 312. NEW NATURAL GAS STORAGE FACILITIES.**

Section 4 of the Natural Gas Act (15 U.S.C. 717c) is amended by adding at the end the following:

"(f)(1) In exercising its authority under this Act or the Natural Gas Policy Act of 1978 (15 U.S.C. 3301 et seq.), the Commission may authorize a natural gas company (or any person that will be a natural gas company on completion of any proposed construction) to provide storage and storage-related services at market based rates for new storage capacity related to a specific facility placed in service after the date of enactment of the Energy Policy Act of 2005, notwithstanding the fact that the company is unable to demonstrate that the company lacks market power, if the Commission determines that—

"(A) market-based rates are in the public interest and necessary to encourage the construction of the storage capacity in the area needing storage services; and

"(B) customers are adequately protected.

"(2) The Commission shall ensure that reasonable terms and conditions are in place to protect consumers.

"(3) If the Commission authorizes a natural gas company to charge market-based rates under this subsection, the Commission shall review periodically whether the market-based rate is just, reasonable, and not unduly discriminatory or preferential.".

Also see Department of Energy, Federal Energy Regulatory Commission 18 CFR Part 284, "Rate Regulation Of Certain Natural Gas Storage Facilities: Final Rule, Order No. 678,71 FR 36612, (June 27, 2006) and Order No. 678-A, 117 FERC ¶61,190 (2006)

[2] U.S. Department of Energy, Forecasting Crude Oil Spot Prices Using OECD Petroleum Inventory Levels.

[3] The Association of Oil Pipe Lines annual report showing shifts in petroleum transportation between the years 1983-2003. A copy of the report is available at www.aopl.org.

[4] "Current State of and Issues Concerning Underground Natural Gas Storage", FERC, Staff Report AD04-11-000, September 30,2004

[5] EIA website for October 2004.

[6] "Winter 2005-2006 Energy Market Update", FERC, Item No.:A-3, March 16, 2006.

[7] "U.S. LNG Markets and Uses", June 2004 Update, EIA, June 2004.

[8] "Monthly Liquefied Natural Gas (LNG) Status Report", Office of Fossil Energy, DOE, May 15, 2006

[9] Observations on Petroleum Product Supply, NPC, December 2004.

[10] As of the November 10, 2004 Weekly Petroleum Status Report, EIA discontinued use of the LOI, stating that they believe that the average inventory ranges provide a better frame of historical reference for analyzing inventories and that the LOI does not add significant analytical value.

[11] Distillate fuel oil use for transportation comprises railroad, vessel bunkering, and on-highway diesel fuel.

[12] April 13, 2006; National Oceanic and Atmospheric Administration (NOAA) reported that temperatures during the heating season of 2006 were the fifth warmest on record. www.ncdc.noaa.gov/oa/climate/research/2006/mar/mar06.html